Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary

Newsletter

Spring 1994

Readers are encouraged to submit brief articles or ideas for articles. Correspondence, including requests for changes in the mailing list, should be addressed to Randy Brown, California Department of Water Resources, 3251 S Street, Sacramento, CA 95816-7017.

EDITORS' NOTE: The following is an unsolicited article and does not necessarily reflect the opinions of Interagency Program managers and coordinators. Written comments on this or other *Newsletter* articles are welcome and will be presented, along with the author's responses, in the summer edition.

The Disastrous Decline of the San Joaquin River and Its Ecology

Alex Hildebrand
Farmer, engineer, member of the Bay-Delta Oversight Council, and a director of South Delta Water Agency

For more than 40 years I have watched the enormous decline of the San Joaquin River and its water-related ecology. For more than 20 years I have listened to biologists and others debate the causes of decline of harvestable fish and fowl, and more recently the survival of listed species. But I hear very little about the interrelationships of impacts of various kinds of fish, aquatic plants, wading birds, frogs, redwing blackbirds, and turtles. And how is the delta's ecology affected by whatever is causing the ecological declines in and along the San Joaquin River upstream of its inflow to the delta's channel network?

My family has owned a farm in the South Delta along the east bank of the San Joaquin River for almost 50 years, and has resided on it for more than 30 years. It is located downstream of the mouth of the Stanislaus River and upstream of Mossdale. We have frontage on the main channel of the river and on an oxbow.

In the early years of our ownership and residence, we swam and boated in the river and the oxbow. We listened to the chorus of big frogs croaking at night, and we saw the turtles that basked on logs in the sun, and the weasels, the muskrats and beavers, the egrets and cranes, and visiting flights of white pelicans. Native fish of many varieties were abundant, and river flows provided ample depths for these activities and these species even at low tides.

Now the water is shallow and so choked with water hyacinth and other non-native aquatic plants that swimming and boating in the oxbow is impossible. The river channel is also no longer attractive. The frogs and turtles and weasels are gone. And the population of fish, muskrats, raccoons, cranes and other water-related creatures is greatly diminished.

What are the causes of this drastic decline? Is it possible to restore this beautiful place and, if so, how?

We can plausibly identify a number of causes, but may not yet know all of them, or which causes are dominant,

CONTENTS

or what synergisms are involved. We need a comprehensive strategy for restoration. We must avoid the temptation to pick some convenient "whipping boys" without establishing whether the problems selected for attention can, if corrected, provide significant restoration without our also addressing other causes.

Plausible causes include, but are not limited to, reduced flows, increased salinity, non-native aquatic plants, non-native fish, channel aggradation, and toxic discharges that may have increased. For most of the species I have mentioned, the introduced aquatic plants appear to be a major problem. (Diligent efforts by the Department of Boating and Waterways provide partial control of hyacinth but not of other aquatic plants.) I do not know how various species may have been affected by increased salinity or by toxins. Nor is it clear to what extent increased salinity and any increase in toxins would be a problem if the flow were not reduced. The lack of flow might be less serious for some species if there were a channel maintenance program. There is no such program, and the elevation of the river bottom from Vernalis to Paradise Cut has been raised by sedimentation during recent decades from below low tide level to above low tide level.

Since about 1950, the inflow of the San Joaquin River to the delta has been, and still is being, greatly reduced. There are long periods when there is no net outflow from the river to the Central Delta. This causes reaches of stagnant water and inadequate dissolved oxygen for fish. Upstream appropriative rights granted by the State often exceed the yield of the river system, and direct diversion rights are based on diversion amounts rather than on consumptive use. Appropriators, therefore, keep increasing their consumptive use of water they divert, with a consequent reduction in return flows. Exports from the Tuolumne River to the Bay Area bypass the stream system and have increased about fivefold over the last 40 years. Appropriators on the tributaries with inferior water rights have not been required to bypass sufficient unimpaired flows to protect superior mainstem and South Delta water rights and natural channel depletions. And the net effect of CVP operations is to reduce river flow upstream of Vernalis by about 110,000 acre-feet in dry years and 500,000 acre-feet in below-normal years, according to the June 1980 joint report by USBR and SDWA on "The Effects of the CVP upon the Southern Delta Water Supply".

The substantial increase in river salinity is caused primarily by CVP operations. The June 1980 report indicated that the increase in salt load at Vernalis attributable to the CVP during the period examined in the report averaged 102,000 tons in dry years and 129,000 tons in below-normal years. Later, updated studies indicate that a very large majority of the more recent level of salt load in spring and summer months is attributable to the CVP, and that the CVP service area introduces about 30,000 tons of salt per month into the river in those months when flows are typically low.

It is difficult to imagine that the SWP can have caused any of the degradation I have described. In fact, the project is probably harmed by this degradation of the river inflow. The CVP has contributed substantially to flow reduction in the San Joaquin River, but it is clearly not the only cause of that reduction and is not an increasing cause. The CVP salt load has impacted agriculture along the mainstem and in the South Delta, but it is not clear what effect it has had on each of the various aspects of the ecology in and along the river. We do not know whether the impact of reduced flows on resident fishery is as great as the impact of the recent proliferation of non-native aquatic plants. Higher flows would help somewhat to control these plants, but not in oxbows and other backwater. Massive hyacinth growths have impeded migration to and from salmon spawning beds.

How, then, will we restore this degraded waterway? There are no obvious quick fixes. A comprehensive strategy will be required. We don't yet know how much and what mix of fixes is needed or how much this upstream degradation is contributing to degradation in the delta. Let us not fail to address this complex problem, but let us also not seek simplistic solutions, and let us not look only at salmon and striped bass. They don't provide us with a chorus at night, and whatever has killed the frogs appears to have been hard on numerous other water-dependent creatures as well.

Central Valley Project Improvement Act

One provision of the CVPIA is to develop and implement a plan to double the populations of several anadromous fish by 2005. The "doubling plan" is to be available for implementation by the end of 1995. Interagency staff will play a key role in developing the plan and monitoring its success. Marty Kjelson (USFWS) chairs the Interagency Core Team, which also includes Ken Lentz (USBR) and Randy Brown (DWR).

The actual work of drafting plans to double fish populations is falling on several technical teams, including delta teams for striped bass, sturgeon, and fish passage. Upstream teams include Sacramento mainstream salmonids, tributary salmonids, American shad, and the San Joaquin system. The Core Team may also establish a group of mainly biometricians and population dynamics specialists to help determine how we determine if the goal of doubling these populations has been achieved.

Team members should be submitting draft plans by this fall. Updates will be provided in this *Newsletter*.

Research Enhancement Program

The following progress and final reports have been submitted by researchers who received REP grants — a program supported by Interagency members and the San Francisco Estuary Project. Call Lisa at 916/323-7203 if you would like a copy of any of these reports.

The Wetlands of Suisun Bay Region as Ecological Indicators of Salinity Regime: Historical Context and Scientific Rationale
Regents of the University of California
Dr. Theodore C. Foin

Hydrodynamics of the Exchange Between San Francisco Bay and the Coastal Ocean
University of California, San Diego
Dr. John L. Largier, Assistant Research Oceanographer, Scripps Institution of Oceanography

Bioconcentration and Metabolic Fate of a Petroleum-Based Hydrocarbon in Striped Bass
University of California, Santa Cruz
Dr. Ronald S. Tjerdesma, Institute of Marine Sciences

Interactive Influences of Starvation and Predation on Mortality of Larval Striped Bass
University of California, Davis
Dr. Peter B. Moyle, Dept. of Wildlife and Fisheries Biology

An Interspecific Comparison of Metal Bioavailability in San Francisco Bay: Comparison of Solute and Particulate Source Terms
U.S. Geological Survey
Mr. Nicholas S. Fisher
State University of New York
Dr. Sam Luoma

Hydrodynamic Influences on the Survival of Wetlands in San Francisco Bay
University of California, Berkeley
Dr. Rodney Sobey, Dept. of Civil Engineering

Ecology and Potential for Control of the Invasive Alien Saltmarsh Cordgrass, Spartina Alterniflora, in San Francisco Bay
University of California, Davis
Dr. Donald R. Strong, Bodega Marine Laboratory

Reproductive Cycle and Gametogenesis of Delta Smelt
University of California, Davis
Dr. Serge Doroshov, Dept. of Animal Sciences

Pore Water Geochemistry of Trace Elements in the South Bay
University of California, Santa Cruz
Dr. A. Russell Flegal, Research Geochemist, Institute of Marine Sciences

Environmental Requirements and Tolerances of the Sacramento Splittail
University of California, Davis
Dr. Joseph J. Cech Jr., Dept. of Wildlife and Fisheries Biology

Stress Proteins in Amphipods as Biomarkers of Sediment Pollution in San Francisco Bay
San Francisco State University
Dr. James T. Hollibaugh, Tiburon Center for Environmental Studies

Aggregation of Petroleum Hydrocarbons with Particles in Urban Runoff and Estuarine Waters
University of California, Berkeley
Dr. James R. Hunt, Dept. of Civil Engineering

Pre-Historic Salinity Record in San Francisco Estuary
Stanford University
Dr. James C. Ingle, Dept. of Geological & Environmental Sciences

An Investigation of the Effects of Elevated Water Temperature on Some Aspects of the Physiological and Ecological Performance of Juvenile Chinook: Implications for Management of California's Central Valley Salmon Stocks
University of California, Davis
Dr. Joseph J. Cech Jr., Dept. of Wildlife and Fisheries Biology

Movements, dive behaviors, and food habits of harbor seals (Phoca vitulina Richards) in San Francisco Bay, California (Final Report)
Moss Landing Marine Laboratories
James T. Harvey and Michael L. Torok

Winter Chinook Captive Broodstock Program

Paul Siri
Assistant Director of Bodega Marine Laboratory and a participant in the Winter Run Captive Breeding Program

From 1969 to 1991, the estimated number of adult winter Chinook salmon plummeted from about 120,000 to 191. Nat Bingham of the Pacific Coast Federation of Fishermen's Associations, determined not to let this distinct subspecies of salmon slide into oblivion, brought together state and federal fisheries biologists and water agency managers and biologists to develop a captive breeding program to act as an insurance policy to back up the wild winter Chinook should it slip into further decline. This group, which became known as the "Winter Run Chinook Captive Broodstock Committee", established a goal to develop a breeding program similar to the California condor captive breeding program. Major support for the program comes from DWR, USBR, DFG, and National Marine Fisheries Service.

The challenges were daunting. Keeping wild salmon in captivity is inherently much more difficult than managing birds in captivity. Salmon are strong, but frail to human touch. Disease transmission in water is tough to control. Fish are difficult to tag for inventory purposes, and salmon demand extremely high water quality. Additionally, genetic management of a species that has declined to near extinction requires intensively planned mating strategies and gene resource identification to reverse a genetic bottleneck — the process of increasing the genetic diversity of a species that has little diversity to begin with.

The Captive Broodstock Committee solicited the help of the University of California at Davis, the Bodega Marine Laboratory, and the California Academy of Sciences Steinhart Aquarium. BML had the ability to rear salmon in both freshwater and seawater environments and to provide the migratory transition when salmon "smolt", or change from a freshwater to seawater animal. Additionally, BML could provide the requisite genetic management under the leadership of Dr. Dennis Hedgecock, a population geneticist who works with marine animals. Hedgecock's lab is equipped for genetic analysis at a molecular level. With limited numbers of wild fish to work with, it is critical to describe the existing winter run genetic resources at a DNA level. Together with USFWS personnel, Hedgecock has developed appropriate protocols for mating the broodstock fish with wild fish collected in the Sacramento River and retained at Coleman National Fish Hatchery, on Battle Creek near Redding.

The project is now in its third year. It was preceded by a great deal of experimentation by USFWS personnel at Coleman to develop techniques to keep the wild adult fish alive in captivity until spawning. In 1992, the first full year of the expanded project, 747 winter run juveniles were transferred to BML, where participants dedicated a new facility built specifically to rear winter run for 3 to 4 years. The table below summarizes recent estimated run sizes, numbers of adults captured for the Coleman Hatchery Winter Chinook Program, and numbers transferred to BML.

Every year until the run and the habitat improve, the project expects to breed as many wild fish as possible at Coleman. If sufficient wild fish are not collected, then captive broodstocks will be mated with wild fish. With good egg and fry survival, up to 20,000 or more winter Chinook can be released at Coleman and 1,000 brought to BML for maturation and future mating. After the fish are smolted to seawater, up to 250 are transferred to Steinhart Aquarium for insurance in the event of a catastrophe at BML. A few of the Steinhart winter Chinook are on display for public education.

What began as an insurance program is now paying off. Wild winter Chinook are now declining to numbers that all but ensure extinction without intervention. In 1993, the run size was estimated at 342; this year run size is estimated at 200. The Captive Breeding Program attempts to capture about 20 fish a year. As of April 1 this year, only three fish had been captured in the upper Sacramento River, and only a single female is alive for mating. The run is considered complete in May. BML and USFWS personnel have developed a contingency mating program if no more wild winter run are collected so that the Captive Breeding Program will provide the necessary milt to fertilize the one wild female. Additionally, candidate spawners have been identified to provide more progeny if necessary.

In early January, BML had about 340 winter Chinook from the 1991 brood year and about 500 from the 1992 brood year. Cumulative mortality for the 1991 brood year has been about 45%. In March, the 1991 brood year salmon averaged about 870 grams and about 400 mm long. If these salmon had migrated to the ocean during their

Summary of Winter Run Chinook Captive Breeding Program

Year	Estimated Run Size	Adults Captured	Females Spawned	Eggs Collected	Juveniles Released	Juveniles Transferred to BML
1989	553	42	1	6,169	3,203	0
1990	441	25	2	5,012	1,286	0
1991	191	23	9	29,475	11,582	747
1992	1,180	69	13	59,445	28,099	950
1993	342	24	10	47,157	18,723	941
1994*	200	3				

* Through April 1.

first year of life, they would now be returning upriver to spawn during late spring and early summer, and they might average more than 3000 grams and 500 mm long.

In spite of their small size, the 1991 winter Chinook are becoming sexually mature. By early this year, more than three-quarters of the fish were beginning to show secondary sexual characteristics, and about 14% could be classified as "jacks".

The 1991 broodstock were thought to be somewhat experimental. Being the first brood year of the project, they were smolted one year late. They also experienced a significant outbreak of BKD. It was generally believed that these fish would have low survivorship and were not likely to provide gametes for future mating. The Winter Run Committee assumed that 20% survivorship for any one brood year would be optimistic at the end of 3 years. As mentioned, 1991 survivorship is currently about 45%.

Gamete quality is now a primary objective. Disease treatment using antibiotics retards growth. Smaller fish are likely to be less fecund, so there are risky tradeoffs in balancing fish health, survivorship, and total egg production. A major hurdle is to develop maturation synchrony so that eggs and sperm are available when needed. Synchronizing broodstock gametes with wild fish gametes at Coleman creates further logistical problems. BML and USFWS personnel are assessing various techniques to synchronize maturation. Part of the difficulty rests in needing to reintroduce candidate spawners into fresh water, which provides an environmental cue for production of various hormones that comprise part of a larger complex of maturation changes necessary for successful development of gametes.

A volitional spawning tank is being designed that will allow fish to reenter fresh water at their own pace. If fish don't synchronize according to the mating calendar of the wild fish, then broodstock can be implanted with one of several precursor hormones that precede final ovulation. The greatest challenge to winter run researchers is assessing what stage of development the fish are in at any given time. We are hoping to find a non-invasive assay for any number of proteins that indicate maturation. Taking a surface mucus sample is greatly preferable to invasive measures such as sampling blood plasma. During the next year, we will focus intensively on developing these techniques.

The Winter Run Captive Breeding Program and a similar project in Idaho are establishing new technology for future hatchery practices, where wild fish can be retained and brought into hatchery production to preserve and reinforce valuable genetic resources. The American Fisheries Society is reviewing captive breeding practices to make national recommendations on how to go about preserving wild fish. Last September, DWR, working with the National Fish and Wildlife Foundation, sponsored an important meeting at BML during which many of these discussions were initiated.

The future of Pacific salmon is uncertain, but if the creative energy and motivation exemplified by the Winter Chinook Captive Breeding Program is any indication of how agencies can work together, then there is some hope.

Culture of Delta Smelt and Control of Associated Mycobacterial Disease

Serge Doroshov and Ronald Hedrick
University of California, Davis

The Delta Smelt Project, funded by DWR and USBR, aims to establish laboratory culture and artificial reproduction of delta smelt, a threatened species with an apparent infection of *Mycobacterium* sp. The infection origin is not known, but wild stock may be carriers of this chronic disease. In salmonid culture, similar disease problems are successfully managed by rearing isolated fish colonies in an optimal environment and monitoring health condition and infection in cultured populations.

During late fall 1993, immature wild fish were seined at several delta locations. DFG crews assisted in broodstock procurement. Careful handling and transportation in the isotonic solution with MS-222 reduced stress and improved survival.

Four groups (500 fish total) were raised on an artificial diet in isolated recirculation systems with controlled temperature, photoperiod, biological filtration, and UV sterilization. Growth, gonadal development, and health were monitored by monthly sampling.

By March 1994, broodstocks had gained 150% in body weight and had reached 70 mm mean total length, similar to that of spawning population. Gonadal development was normal and was approaching final stages of maturity. *In vitro* bacterial culture and histology did not reveal the presence of mycobacterial disease.

Artificial breeding will be attempted in April and May, using natural spawning in tanks and *in vitro* insemination. Larvae will be raised to metamorphosis in brackish-water tanks with an upwelling flow and will be fed cultured live food and artificial diets.

If successful, this project will elucidate reproductive biology and health conditions of the delta smelt population. New culture and breeding techniques may be used for conservation and rehabilitation of this species.

San Francisco Bay: The Ecosystem —
An Important Symposium at the Pacific Division AAAS 75th Annual Meeting

San Francisco Bay: The Ecosystem
Monday-Wednesday, June 20-22, 8:30-5:00 daily.

Sponsored by:
Romberg Center for Environmental Studies
San Francisco State University
U.S. Geological Survey Water Resources Branch
Pacific Division Sections on Environmental, Earth, and Biological Sciences

Organizer:
James T. Hollibaugh, Romberg Center for Environmental Studies
San Francisco State University, Tiburon, CA.

DRAFT PROGRAM

Plenary Session: What Role Do Estuaries Play in the Global Biogeochemical Cycling of Cargon, Nitrogen, and Phosphorus?
S.V. Smith (Department of Oceanography, University of Hawaii, Honolulu)

Session I: Water Properties and Quality

Comparison of biogeochemistries of cadmium and cooper in San Francisco Bay.
A. Van Green, C. Brown, M. Hornberger, S. Luoma (USGS, Menlo Park, CA)

Implications of dissolved sulvides and organic substances on the chemical speciation of trace inorganic contaminants in the oxide water column of San Francisco Bay.
J.S. Kuwabara, C.Y.C. Chang, Y.R. Hunter (USGS, Water Resources Division, Menlo Park, CA)

Factors controlling nickel and copper speciation in south San Francisco Bay.
J. Donat and K. Bruland (University of California, Santa Cruz)

Biogeochemical cycles of inorganic contaminants in the San Francisco Bay Estuary.
A. Flegal, G. Smith, G. Scelfo, J. Crick, S. Andudo-Whilhelmy, P. Ritson, I. Rivera-Duarte, K. Abu-saba (Institute of Marine Sciences, University of California, Santa Cruz)

Molecular marker compounds as indicators of anthropogenic contamination in San Francisco Bay Estuary.
W.E. Pereira, F.D. Hostettler, J.R. Cashman, R.S. Nishioka (USGS, Menlo Park, CA; IGEN Research Institute, Seattle, WA; and University of California, Berkeley)

The supply of suspended sediment to San Francisco Bay from the Sacramento River. I. Factors affecting suspended particle transport.
L.E. Schemel, S.W. ~~Hager, D. Childers~~ (USGS, Menlo Park, CA)

The supply of suspended sediment to San Francisco Bay from the Sacramento River. II. Carbon and nitrogen content of suspended particles.
S.W. Hager and L.E. Schemel (USGS, Menlo Park, CA)

Factors affecting the distribution of plant nutrients in southern San Francisco Bay: Investigations using a mass balance approach.
S.W. Hager and J.M. Caffrey (USGS, Menlo Park, CA)

Session II: Physical Processes

San Francisco Bay salinity: Observations, numerical simulation, statistical models, and atmospheric-delta flow correlations.
D. Peterson, D. Cayan, M. Noble, R. Smith, L. Schemel, R. Uncles, R. Waters (USGS, Water Resources Division, Menlo Park, CA)

Hydrodynamic transport and mixing processes in Suisun Bay.
S.G. Monismith, J. Burau, M. Stacey (Environmental Fluid Mechanics Laboratory, Stanford University, Stanford, CA)

The Late Holocene sedimentary record of San Francisco Bay studied using isotope geochemistry, high resolution seismic profiles, and faunal distribution.
L. Ingram, J.S. Engle, G. Mann, M. Marlow, R. Anima (USGS, Water Resources Division, Menlo Park, CA)

Session III. The Ecosystem

Interannual variability in estuarine photoplankton communities: San Francisco Bay/Delta California.
A. Jassby (University of California, Davis)

Sources and reactivity of organic matter in San Francisco Bay.
E.A. Canuel (USGS, Water Resources Division, Menlo Park, CA)

Benthic processes in San Francisco Bay: Role of organic inputs and bioturbation.
J.M. Caffrey, D.E. Hammond, J.S. Kuwabara, L.G. Miller, R. Twilley (USGS, Menlo Park, CA)

Distribution and activity of bacterioplankton in San Francisco Bay and the relationship between sources of organic matter, community composition, and community metabolic capabilities.
J.T. Hollibaugh and P.S. Wong (Center for Environmental Studies, San Francisco State University, San Francisco, CA)

Water column respiration in San Francisco Bay during a "wet" year: The influence of physical, biological, and seasonal variability.
J. Rudek and J.E. Cloern (USGS, Menlo Park, CA)

Summary of federal and state water project environmental impacts in the San Francisco Bay-Delta, California.
J. Arthur, M.D. Ball, and Sheryl Baughman (USBR, Mid-Pacific Region, Sacramento, CA)

8,000-Year sedimentary record of environmental and climatic change in San Francisco Bay.
B.L. Ingram (Lawrence Livermore Laboratory, University of California, Berkeley, CA), J.C. Ingle (Department of Environmental and Geological Studies, Stanford University, Stanford, CA), and G. Mann, M. Marlow, R. Kayen, R. Anima (USGS, Palo Alto, CA)

Session IV: Fisheries Resources

An evaluation of the effectiveness of fish salvage operations at the intake to the California aqueduct, 1969-1993.
R. Brown, S. Greene (DWR, Sacramento, CA) and P. Coulston, S. Barrow (DFG, Stockton, CA)

Where have all the fishes gone?
P.R. Moyle and W.A. Bennett (Department of Wildlife and Fisheries, University of California, Davis)

Relationship between flow and survival of delta smelt in the Yolo Bypass.
P.R. Moyle (Department of Wildlife and Fisheries, University of California, Davis)

Factors controlling the habitat of Neomysis in San Francisco Bay.
J. Orsi (DFG, Stockton, CA)

Fish populations of San Francisco Bay: Relationship to freshwater flow.
C. Armor and K. Hieb (DFG, Stockton, CA)

Effects of agricultural runoff on the survival of striped bass larvae in the Sacramento River and Suisun Bay.
B. Bennett (University of California, Davis) and C. Foe (Regional Water Quality Control Board, Sacramento, CA)

Session V: Epilog

Update of "San Francisco Bay: The Unsuspected Estuary".
J. Hedgpeth (Santa Rosa, CA)

The United States Geological Survey and San Francisco Bay: 25 Years of Involvement.
T.J. Conomos (USGS, Menlo Park, CA)

Estimating Winter Run Survival with Late-Fall Run Fish

John Wullschleger, USFWS

Knowledge of Chinook salmon smolt survival in the Sacramento River and the delta is primarily based on studies using fall run fish. Factors found to affect survival include temperature, export rate, size of fish, percent diversion, and the path taken to the ocean. In general, smolts diverted into the central delta exhibit lower survival than those that remain in the main river channel. Recently, attention has become focused on Sacramento winter run salmon, which has been listed federally as an endangered species. The National Marine Fisheries Service Biological Opinion includes criteria for protection of winter run smolts, which are believed to be less vulnerable than fall run fish to predation and temperature factors due to their greater size and the relatively cool water temperatures during their outmigration. An Interagency study in December 1993 by the USFWS Stockton Office was designed to acquire information on mortality of winter run smolts in the delta by using late-fall run instead of fall run smolts. Late-fall run smolts are considered reasonable surrogates for winter run fish because of their similar size, and because overlap in their migration periods exposes them to similar, cool water temperatures.

Late-fall run Chinook smolts (1993 brood year) from Coleman National Hatchery were released in the Sacramento River at Ryde (N_R=33,668) and in Georgiana Slough (N_G=34,929) on December 2. All fish were fin clipped to facilitate recognition and implanted with coded wire tags indicating release site and date. Tagged fish were recovered by midwater trawl at Chipps Island and by sampling at the SWP and CVP fish salvage facilities in the southern delta. Methods for estimating survival were identical to those used for studies using fall run fish. Descriptions of field and data analysis methods can be obtained from the USFWS Stockton Office and from Interagency Program annual reports.

Salmon smolts were recovered from December 6 through March 16 at Chipps Island, from December 8 through March 16 at the SWP, and from December 6 through March 19 at the CVP. Peak recovery was December 12 at Chipps Island and December 9-11 at the SWP. For the CVP, most smolts were recovered in December, but no clear peak was observed. Survival indices for both Ryde and Georgiana Sough release groups and the survival index ratio (Ryde:Georgiana Slough) were within ranges observed during previous studies using fall run fish (Table 1). As documented for fall run fish, the survival index was lower for smolts released in Georgiana Slough than for those released at Ryde. Numbers of Georgiana Slough smolts recovered at SWP and CVP fish salvage facilities were among the highest recorded. Further, six smolts (expanded number = 9) released in the Sacramento River at Ryde were diverted to the southern delta and recovered at the SWP fish salvage facility. This occurred even though Q_{WEST} was slightly positive, although exports were very high.

As expected, water temperatures at time of release were lower than during studies with fall run fish (Table 2). Flow variables are reported from the release date through peak recovery at Chipps Island. Although 14-day running averages for Q_{WEST} flow ($Q_{WEST}14$) were slightly less positive relative to those during fall run survival studies, exports were an order of magnitude higher. Delta Cross Channel gates were open during December and the beginning of January but were closed during the rest of the recovery period.

Low survival of fall run Chinook salmon smolts in the central delta is well documented and has been attributed in part to predation and the adverse effects of high water temperature. Results of this study suggest that despite cooler water and the presumed reduced vulnerability to predation, survival for winter run smolts diverted into the central delta is similarly low. Although the expanded recovery rate of late-fall run is considerably higher than for fall run, our results suggest

Table 1
Release Data, Estimated Survival, Number Counted at SWP and CVP Facilities, and Survival Ratio for Experiments with Tagged Fall Run and Late-Fall Run Chinook Salmon Smolts, April 6, 1992, through December 2, 1993

This table has some bogus #s that were fixed in next issue

		Sacramento River at Ryde Releases				Georgiana Slough Releases				
Release Date	Race	Water Temp. (°F)	Mean Fork Length (mm)	Estimated Survival	Expanded Number Counted CVP/SWP	Water Temp. (°F)	Mean Fork Length (mm)	Estimated Survival	Expanded Number Counted CVP/SWP	Ryde: Georgiana Survival Ratio
04/06/92	Fall	64	77	1.36	0 / 34	64	74	0.13	10 / 4	3.30
04/14/92	Fall	63	82	2.15	0 / 0	64	81	0.29	12 / 8	3.00
04/27/92	Fall	67	81	1.67	0 / 0	67	83	0.41	1 / 4	8.30
04/14/93	Fall	58	61	0.41	0 / 0	58	63	0.71	0 / 24	3.15
05/10/93	Fall	59	75	0.86	0 / 0	65	75	0.20	15 / 36	2.96
12/02/93	Late-Fall	57	129	1.19	0 / 9	57	119	0.31	92 / 135	3.80

Table 2
Water Temperature at Time of Release, Mean Export Rate, and QWEST Rate from Release to Peak Recovery at Chipps Island for Experiments with Coded Wire Tagged Fall and Late-Fall Chinook Salmon Smolts, April 6, 1992, through December 19, 1993

Sacramento River at Ryde				Georgiana Slough			
Date of: Release / Recovery	Temp. (°F)	Exports (cfs)	QWEST (cfs)	Date of: Release / Recovery	Temp. (°F)	Exports (cfs)	QWEST (cfs)
04/06/92 04/15/92	64	3073	53	04/06/92 04/20/92	64	2425	499
04/14/92 04/21/92	63	1097	1410	04/14/92 04/20/92	64	1093	1449
04/27/92 05/02/92	67	1578	729	04/27/92 05/04/92	67	1883	749
04/14/93 05/06/93	58	3696	3214	04/14/93 05/12/93	58	3246	3493
05/10/93 05/14/93	59	1497	4161	05/10/93 05/22/93	65	1883	749
12/02/93 12/12/93	57	0316	72	12/02/93 12/19/93	57	0646	509

that in-channel mortality in the central/southern delta continues to account for the low survival of fish diverted off the Sacramento River. This in-channel mortality does not appear to be related to temperature but, rather, caused by some unknown factor. This may be due to the complex central delta hydrology to which the smolts are exposed, which alters their migratory behavior.

The Delta Cross Channel was not a direct factor during this study because release sites were downstream of it. Together, however, the Cross Channel and Georgiana Slough have the capacity to divert about 70% of the flow of the mainstem Sacramento River.

Based on expected mortality rates of diverted smolts, closure of the Cross Channel gates and measures to prevent smolts from entering Georgiana Sough must be considered important components of the effort to prevent further decline of winter run Chinook salmon stocks. It should be noted that closing the Delta Cross Channel can result in increased negative (upstream) flow in the central and western delta, particularly when export rates are high.

Our results showed that smolts released into the Sacramento River downstream of both the Delta Cross Channel and Georgiana Slough can be entrained even when the Cross Channel gates are open and QWEST is positive. This indicates that our understanding of how migrating smolts respond to delta flow patterns is not complete and/or QWEST is not a satisfactory measure of western San Joaquin River flow.

Studies planned by the USFWS Stockton Office as part of the Interagency Chinook salmon monitoring program for 1994 will provide additional information on factors affecting salmon smolt survival in the Sacramento River and the delta.

Annual Interagency Directors Meeting

The Directors met on March 16 to review the proposed program changes and budgets for this year and the next two years. Decisions were:

- The name of the Interagency Program will be changed to eliminate the word "studies". A new name has not been selected.
- The Directors approved conceptual program revisions to include the management team, technical and management advisory teams, and project work teams. The Management Committee will bring detailed plans to the Coordinators for approval.
- The proposed budgets were conditionally approved, with actual budgets to be based on final details of recommended changes in monitoring and special studies and on availability of funding in each agency in future budget years.

The Coordinators will meet on April 15 to discuss results of the Directors Meeting and subsequent meetings of the Management Committee.

Winter Chinook Take in the Delta

The NMFS winter run biological opinion allows a calculated take of 905 for outmigrants from the 1993 brood year. As of April 11, the calculated take had reached 828. During the past several days, the CVP pumps were pumping both state and federal water. The SWP pumps are essentially shut down during this period. (Because of QWEST criteria and low streamflows, combined pumping has been generally restricted to less than 3,000 cfs.) SWP and CVP project operators will consult with fish agencies on April 15 to determine if the CVP should continue to pump SWP water. Indications are that we have passed the peak period of winter run outmigration.

East Coast Striped Bass

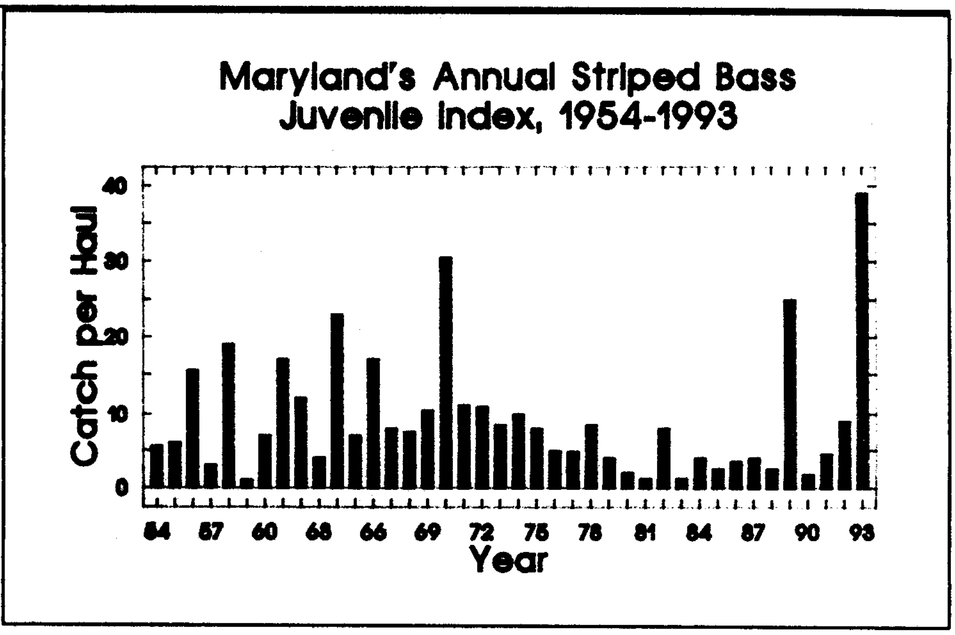
For several years, striped bass populations on the East Coast, especially in Chesapeake Bay, showed trends similar to that observed in the San Francisco estuary. A general decline appeared to start in the early 1970s, and levels were low in the 1980s. (The Hudson River population was a notable exception.) Although there were several possible explanations for the decline, over-fishing seemed to be a major factor. Through a combination of state, federal, and congressional actions, recreational and commercial striped bass catches were reduced along the eastern seaboard for several years. The agencies took other actions to reduce the discharge of toxins and nutrients to the Chesapeake system.

Drastic actions may be leading to recovery of striped bass in the Chesapeake system. As shown in the figure (top right), since 1989 juvenile indices for Maryland have improved considerably, although 1990 was low. The 1993 index was the highest on record. Since several other bay species also had high indices in 1993, improved striped bass survival last year may be indicative of near optimum habitat conditions, as well as the result of past management actions. In 1993, spawning and early growth occurred during a period when flows to the estuary were high and temperatures relatively stable. (During some springs, warming can be followed by a cold front, which reduces survival of the early spawn.)

Harvest is being allowed to increase as the striped bass population recovers. In Maryland, for example, annual catch quotas for the past 4 years have been:

1990	750,000 pounds
1991	1,071,700 pounds
1992	1,865,442 pounds
1993	2,500,000 pounds

The allowable harvest is based on the juvenile index, male and female growth rates, length distribution at age, and maturity schedules.



Maryland's Annual Striped Bass Juvenile Index, 1954-1993

Georgiana Slough Acoustical Barrier

The Georgiana Slough Acoustical Barrier project is being sponsored by the San Luis and Delta Water Authority, DWR, and USBR. All permits have been obtained, and the study began on April 5. This study is an expanded version of last year's program, which showed promising but statistically questionable results. Information from the earlier study was used to design the speaker array in a manner that appears most likely to divert downstream migrating Chinook salmon from entering Georgiana Slough.

The first couple days of sampling produced somewhat unexpected results. On April 5 and 6, four winter-run-size Chinook salmon and nine delta smelt were captured during Kodiak trawling in Georgiana Slough and the Sacramento River. (The Kodiak trawl is a large net, about 30 feet wide by 6 feet deep, towed at the surface between two skiffs.) Since incidental take provisions limit the winter Chinook catch to ten for the entire sampling period and the delta smelt collection to ten in any consecutive 7 days, trawling was suspended at noon on April 6 and resumed April 11 at a reduced schedule.

Bay-Delta Oversight Council

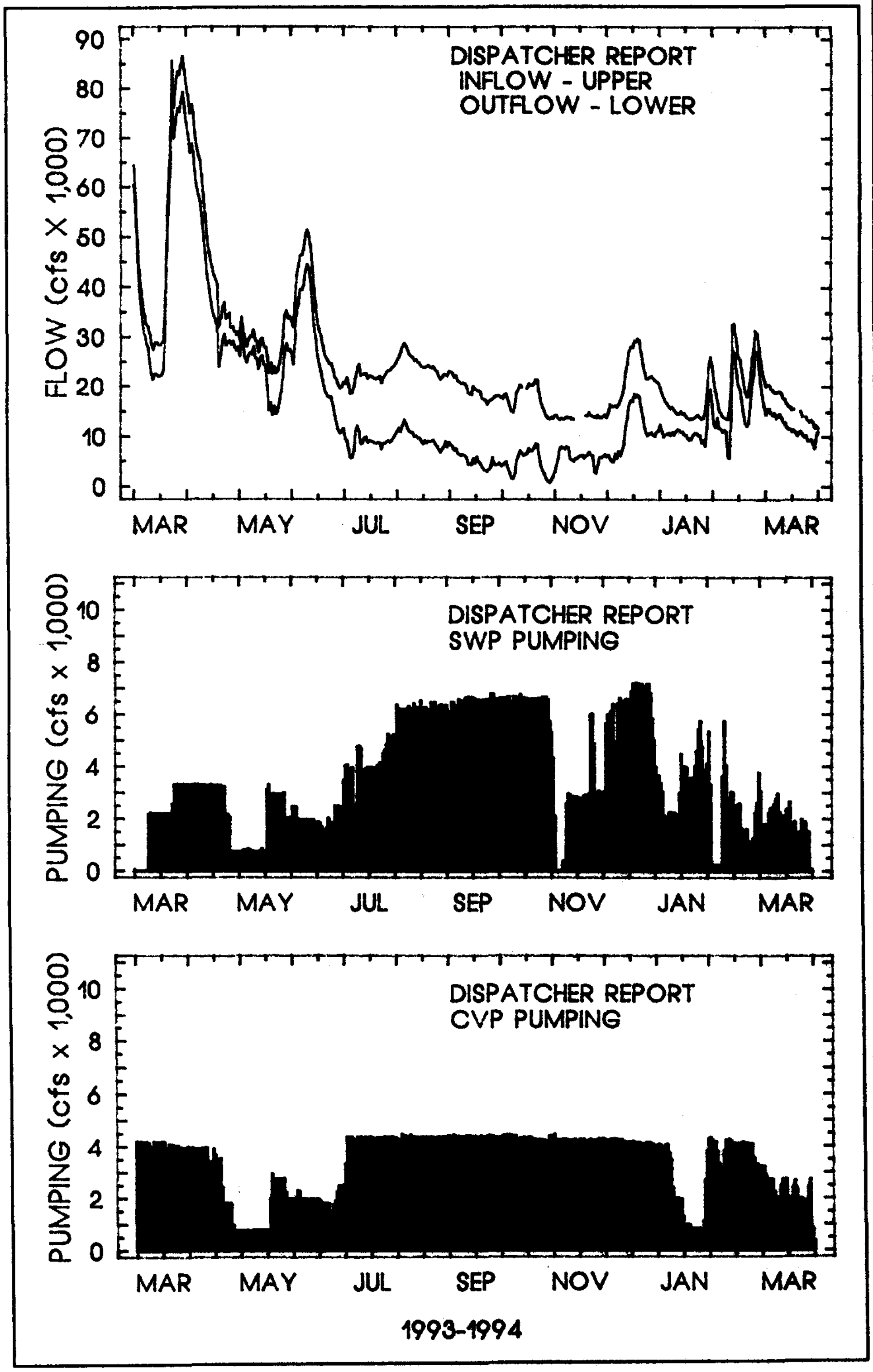
The BDOC recently appointed two biological technical advisory committees — one for aquatic resources and the other for plants and wildlife. The first meeting of these groups will be a joint meeting on April 13. They will likely meet separately in the future.

The aquatic resources TAC is chaired by Perry Herrgesell and also includes Tim Hollibaugh, Randy Brown, Frances Chung, Chuck Hanson, Wim Kimmerer, Randy Bailey, Dave Vogel, Bill Kier, and Irwin Haydock. BDOC has asked this TAC to scientifically evaluate the technical adequacy of possible action alternatives to improve conditions in the estuary for biological resources. The committee will also propose indicators that will help managers determine if the action alternatives are achieving the goals. The TAC will draw much of its information for the analyses from Interagency Program staff and data bases.

Delta Flows

Sheila Greene
DWR

The figures below illustrate delta inflows and outflows and project pumping so far during water year 1994. Combined export pumping was reduced during January to avoid "taking" winter Chinook and because San Luis Reservoir was full. Pumping was variable in February and March to comply with the QWEST requirements. Pumping at the SWP was suspended on March 30 to avoid exceeding the take limit of winter Chinook.



Recent Additions to USFWS Staff

The USFWS Sacramento-San Joaquin Fishery Resource Office in Stockton added two senior fishery biologists to its staff in February. These biologists will help us meet responsibilities resulting from the revised Interagency Program endangered species petitions, USEPA and SWRCB water quality standards, the Central Valley Project Improvement Act, and our revised estuarine monitoring activities.

John Wullschleger comes to us from the Utah Division of Wildlife Resources (where we also recruited Spencer Hovekamp, Assistant Project Leader). John was a regional fisheries biologist for the northern region of Utah, based in Ogden. John got his MS from Colorado State University and worked 4 years as a fishery biologist for the State of Florida.

Dan Castleberry came from the USFWS (now NBS) research station in Dixon. Dan already has extensive experience in California fisheries biology, with emphasis on a physiological approach to fishery problems. Dan has an MS and is near to completing his Ph.D. dissertation at UC-Davis under Dr. Joe Cech.

We are still defining John's and Dan's roles on our team. We anticipate John working on San Joaquin Basin issues and Dan dealing with the delta and mid-valley tributaries (Feather to Calaveras Rivers). Both will be named to Interagency Program work teams and will help on the CVPIA anadromous fish restoration program (doubling plan), for which our office has the USFWS leadership role.

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Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary

Newsletter

A Cooperative Effort of:

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State Water Resources Control Board
U.S. Bureau of Reclamation
U.S. Army Corps of Engineers
California Department of Fish and Game
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